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ABSTRACT

Outlined in this report is the nature and disposition of research and development (R&D) funding on the part of Federal agencies responsible for implementing changing national energy policy objectives for 1971-84. These funding data are presented in three major sections: (1) Federal role in energy R&D support (focusing on recent trends, historical perspectives, and basic research); (2) nuclear energy R&D programs; (3) and non-nuclear energy R&D programs. Introductory material, highlights of major findings (focusing on recent funding trends), and energy R&D programs in the 1983 Federal budget are also presented. The latter include programs related to: solar energy; geothermal energy; nuclear fission; magnetic fusion; electric energy and energy storage systems; biological and environmental research; supporting research; fossil energy; energy conservation; uranium enrichment; as well as Nuclear Regulatory Commission and Environmental Protection Agency programs. Among the findings reported are those indicating: (1) significant shifts in Federal R&D energy funding policy during the past 12 years, in response to events on both the national and international scenes; and (2) growth in the share of energy within the Federal R&D total from 4 percent (1971) to 12 percent (1978-79), and a marked decline to 5 percent in the 1983 budget proposal. (JN)

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foreword

The development of efficient, ample, and price-competitive energy sources has been high on the national agenda for the past decade. Thus, it is not surprising that energy-related R&D programs have made up one of the five largest Federal R&D program areas in terms of funding during this period. An analysis of the evolution of these energy programs since the start of the seventies can provide insights that could be useful in the formulation of future plans and policies.

This report provides such an analysis. It outlines the nature and disposition of R&D funding on the part of the Federal agencies responsible for implementing changing national energy policy objectives in the 1971-84 timespan. It also provides a perspective on some of the actions taken by four successive administrations to meet national energy problems. The focus is on R&D programs with energy support placed within a broader setting of Federal R&D support.

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February 1983

acknowledgments

This report was prepared in the Division of Science Resources Studies under the general guidance of William L. Stewart, Head, R&D Economic Studies Section. Eleanor H. Stoddard, Study Director, Government Studies Group, provided direction. Joseph J. Geraci was responsible for developing the data and writing the text. Dorothy K. Ham prepared the graphic illustrations.

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introduction

Energy has been a major area of Federal R&D support for a number of years. This support has been characterized by rapid shifts in the size of funding and in the nature of program direction in response to changing events. The current administration has brought a new and significantly different approach to the energy issue than that which prevailed previously, and energy R&D priorities have been reordered accordingly. The 1984 budget has continued the directions begun in the 1982 and 1983 budgets: Federal demonstration programs designed to encourage commercialization of nonnuclear energy technologies are being phased out as price, tax, and regulatory incentives are provided to encourage private investment. Continued support is given, however, to nuclear programs of a long-run, high-risk nature that are beyond the present capabilities of private industry, as well as to basic research in the energy sciences.

The data presented in this analysis are derived from the National Science Foundation (NSF) compilations of Federal R&D funding by budget function for fiscal years 1971 through 1984. These data provide the framework for the discussion of support trends in various energy program areas and for an analysis of program interrelationships. It should be noted that R&D plant data are excluded.

The energy R&D programs covered are those that fall within the energy function of the Federal budget, as determined by the Office of Management and Budget (OMB). Some programs conducted by the Department of Energy (DOE), although energy-*related*, fall within other budget functions and are not covered here.

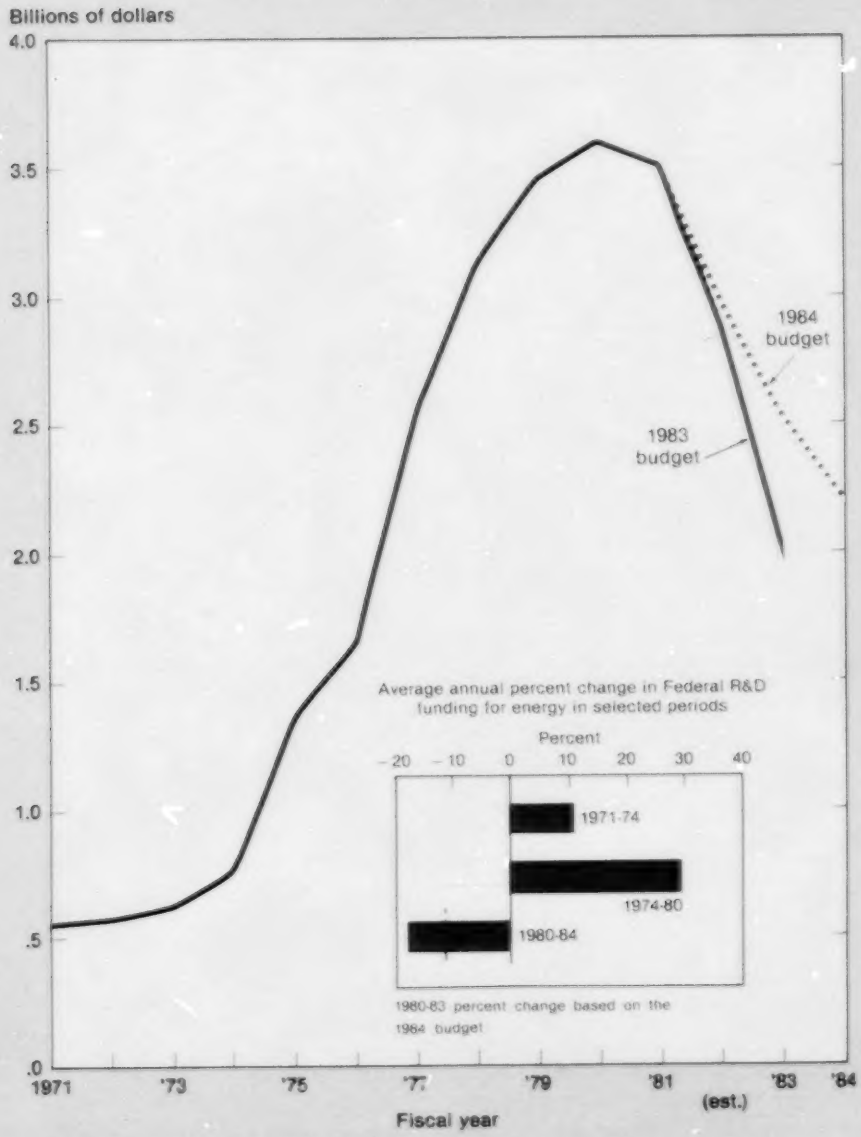
Money amounts for fiscal years 1978-84 are based on budget authority since this is the basis used by Congress in making authorizations and appropriations. Amounts for fiscal years 1971-77 are based on obligations since data for these earlier years are not available in budget authority.

The major research for this report focused on the 1971-83 period. Just prior to publication, however, preliminary funding levels for energy R&D activities, as proposed in the President's 1984 budget, became available. It was, thus, possible to include these data for major energy program areas, bringing the retrospective review as far as budget planning for 1984 and providing more recent estimates of 1983 program funding levels.

The most recent indications of energy R&D funding trends are discussed in the Highlights and briefly in the opening paragraphs of this report. At the time of publication, only broad estimates could be made of 1984 proposed funding levels. A detailed review of energy R&D programs in the 1984 budget will be presented in *Federal R&D Funding by Budget Function: Fiscal Years 1982-84*, to be released in May 1983.[1] The chapter on energy in that report can be directly compared with similar data shown in the previous function report for fiscal years 1981-83 that are published in the appendix to this publication.

[1] Available on request from the National Science Foundation, Division of Science Resources Studies.

Trends in Federal R&D funding for energy



SOURCE: National Science Foundation

highlights

• R&D budget authority for energy programs in the 1983 budget marked the third consecutive year of a decline in funding. The $2,034 million proposed for energy (excluding R&D plant) was down $855 million, or 30 percent, from the 1982 level. This request included the phasing down, or elimination, of federally sponsored R&D programs designed to accelerate new energy technologies but included maintenance of a Federal role in R&D projects that the private sector would be unlikely to support because of their long-term, high-risk nature. Cutbacks were requested in a number of energy programs as price increases, tax credits, and regulatory incentives were planned to encourage private investment.

• Subsequent congressional appropriation actions raised R&D authority for energy to $2,533 in 1983, still 13 percent below the 1982 level but nearly 25 percent higher than the level requested in the 1983 budget. Congress partially restored funds that had been cut from several alternative energy development programs and raised biological and environmental research above, instead of below, the 1982 level.

• The 1984 budget reflected the same strategy emphasized in the 1983 budget; energy R&D funding was proposed at $2,217 million, down $316 million from the 1983 level, or 12 percent. The 1984 budget called for sharp reductions in alternative-technology areas and increases in the areas of nuclear fission and magnetic fusion as well as in supporting research.

• Since the start of the seventies three funding patterns are evident in Federal R&D support to energy. In the 1971-74 period growth in funding was fairly rapid; although at an average rate of 10.9 percent per year, this still did not represent the fastest-growing area of R&D investment. In the 1974-80 period, the rate of funding rose to an unprecedented 30.0 percent, annually, higher than for any other budget function. The 1980-84 period embodied a reversal: based on the 1984 budget, the average annual rate of decline for energy was 11.4 percent, greater than for any major function.[2]

• Support to energy R&D programs increased from 4 percent of the Federal R&D total in 1971 to 12 percent in 1978 and 1979. In the 1984 budget, however, the energy share was 5 percent.

• The share of nuclear programs within the energy R&D total rose after 1980, when it was 40 percent, to an estimated 69 percent in the 1983 budget. Subsequent congressional actions, raising nonnuclear program funds, reduced the nuclear share considerably in 1983—to 56 percent. In the 1984 budget, however, nuclear programs were an estimated 67 percent, continuing the earlier trend.

• The 1983 budget reduced nuclear support by 12 percent from the 1982 level, reflecting a shift in emphasis from fission to high-risk magnetic fusion concepts. Congressional actions produced relatively small changes in individual nuclear program levels in 1983 so that the overall level was little changed. Increases in three of the four major nuclear programs in the 1984 budget indicated a net gain of 6 percent over 1983 for nuclear programs as a whole but the level was still lower than 1982, by 7 percent.

• Nonnuclear energy R&D programs began to show significant growth in 1974 after three years of almost level funding, increasing more than sevenfold by 1980. In 1981, however, overall funding support for these programs decreased 8 percent, although cuts varied selectively. Since then, almost all nonnuclear programs have received substantial reductions. In the 1983 budget, nonnuclear programs accounted for approximately 31 percent of the energy R&D total (compared with 54 percent in 1975). Congressional appropriation actions increased the 1983 share to 44 percent. For 1984, however, the nonnuclear portion of the proposed energy R&D total was 33 percent.

• Basic research support within the energy function grew each year from 1974, when total funding was $89 million, to 1983 when the total budget proposal was $276 million, or 15 percent above the 1982 level. Congressional action on the 1983 request resulted in an increase to $286 million. Thus, the average annual rate of growth was an indicated 12.7 percent during the 1980-83 period (compared with 14.6 percent between 1974 and 1980). In the 1984 budget, the basic research total for energy was $322 million, up 13 percent over 1983. This was in direct contrast to the 12-percent decline indicated for all energy R&D programs in 1984.

[2] Major functions are defined as those with R&D funding of $500 million or more in the 1983 and 1984 budgets.

section 1.

the federal role in energy r&d support

In the past 12 years Federal R&D funding in the energy area has reflected significant shifts in policy in response to events on both the national and international scenes. The share of energy within the Federal R&D total grew from 4 percent in 1971 to a high of 12 percent in 1978 and 1979, but thereafter it declined markedly to 5 percent in the 1983 budget proposal. Subsequent congressional actions, however, produced an increase in the energy share to 7 percent. In the 1984 budget proposal the share was, once again, 5 percent (chart 1).

recent trends

While the total energy R&D effort at present is far greater than at the start of the seventies, the balance among major programs appears to be moving closer to the pattern in the earlier period when nuclear R&D efforts predominated. Federally sponsored work on renewable energy sources and fossil energy was deemphasized in the 1983 budget in contrast to the strong Federal buildup in these areas from 1975 until 1982 (table 1). Despite the partial restoration by Congress of proposed cuts in a number of nonnuclear programs in 1983, efforts in this area are on the decline. The 1984 budget continued the strategy of reduction in these programs while continuing to support the nuclear area as well as energy basic research.

In the 1984 budget, total R&D budget authority for energy R&D programs (excluding R&D plant) was $2,217 million, 12 percent lower than the 1983 total (table 2). Within this total the amount proposed for nuclear programs was an estimated $1,486 million, up 6 percent over 1983. The amount proposed for nonnuclear programs was an estimated $731 million, down 35 percent from 1983. These figures are broadly calculated and subject to some change when more detailed data are available, but the general pattern will remain the same.

The following analysis of energy R&D funding trends covers the period 1971-83 and does not carry the data beyond levels proposed in the 1983 budget. Data for 1982 and 1983 are estimated. Energy programs are defined as those that are included in the energy function of the Federal budget.

Table 1. R&D budget authority for energy in the 1983 budget
[Dollars in millions]

Program	1981 actual	1982 estimate	Percent change 1981-82	1983 estimate	Percent change 1982-83
Total	$3,501.4	$2,888.6	-18%	$2,033.7	-30%
Nuclear programs	1,503.4	1,598.4	+6	1,398.5	-13
Nonnuclear programs	1,998.0	1,290.2	-35	635.2	-51

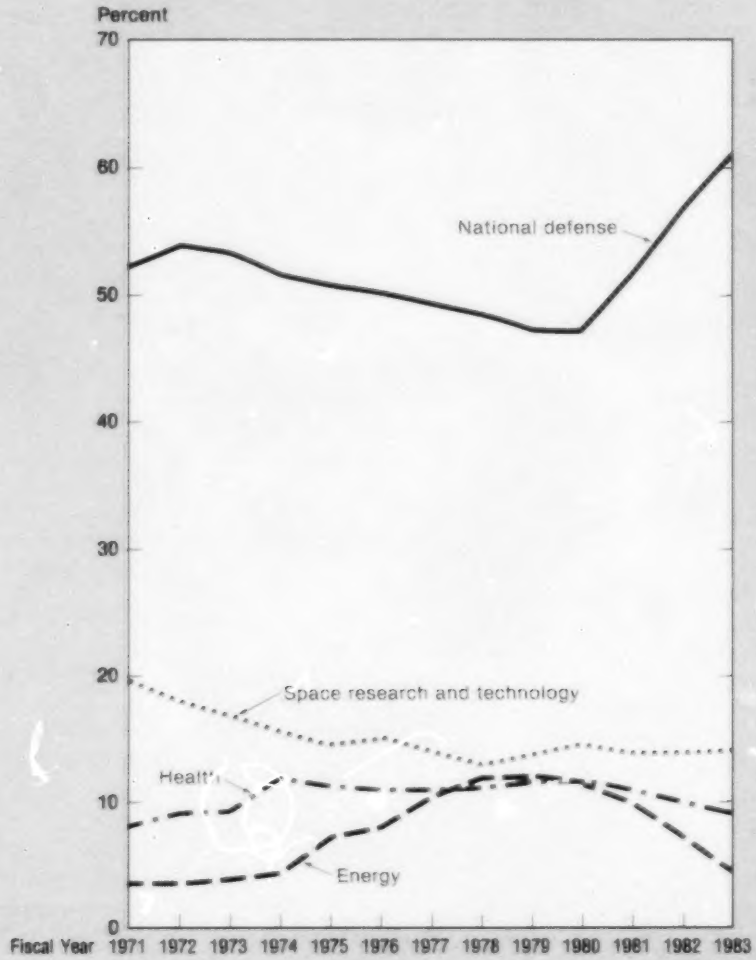
SOURCE: National Science Foundation

Table 2. R&D budget authority for energy in the 1984 budget
[Dollars in millions]

Program	1982 actual	1983 estimate	Percent change 1982-83	1984 estimate	Percent change 1983-84
Total	$2,920.2	$2,533.2	-13%	$2,217.3	-12%
Nuclear programs	1,603.7	1,407.7	-12	1,486.4	+6
Nonnuclear programs	1,316.5	1,125.5	-15	730.9	-35

SOURCE: National Science Foundation

Chart 1. Trends in distribution of Federal R&D funding by function



Fiscal Year	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982 (est.)	1983 (est.)
General science	3.3	3.8	3.9	4.3	4.3	4.1	4.1	4.0	3.9	3.9	3.8	3.6	3.5
Transportation	4.7	3.4	3.4	4.0	3.3	3.0	3.0	2.9	2.7	2.6	2.4	1.9	1.9
Natural resources and environment	2.7	2.9	3.3	3.0	3.3	3.3	3.1	3.4	3.5	3.2	3.0	2.5	1.9
Agriculture	1.7	1.8	1.8	1.8	1.8	1.8	1.9	1.9	1.9	1.9	1.9	1.8	1.7
International affairs	.2	.2	.2	.1	.2	.2	.3	.2	.4	.4	.5	.4	.4
Education, training, employment, and social services	1.4	1.4	1.7	1.4	1.3	1.2	1.0	1.3	1.2	1.5	.8	.5	.4
Veterans benefits and services	.4	.4	.4	.5	.5	.5	.4	.4	.4	.4	.4	.3	.3
Commerce and housing credit	.6	.3	.3	.3	.3	.3	.3	.3	.3	.3	.3	.3	.2
Community and regional development	.4	.4	.5	.5	.5	.5	.4	.3	.4	.4	.3	.2	.1
Income security	.9	.6	.6	.4	.4	.2	.2	.3	.2	.2	.1	.1	.1
Administration of justice	.1	.1	.2	.2	.2	.2	.1	.2	.2	.1	.1	.1	.1
General government	(1)	(1)	(1)	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1

[1]Less than .05 percent.
SOURCE: National Science Foundation

historical perspectives

Federal support to energy R&D programs in the 1971-83 period has moved through three distinct cycles, reflecting major changes in Government policy. In the early seventies the chief emphasis was on the development of commercial nuclear reactors and peaceful uses of isotopes and nuclear explosives. Funds were included for the early stages of work toward development of an economic liquid metal fast breeder reactor (LMFBR) to meet electric power needs. Supporting research in the basic energy sciences was also funded, as were basic and applied programs in the physical and biomedical sciences. All of these programs were conducted by the Atomic Energy Commission (AEC).

When the Organization for Petroleum Exporting Countries (OPEC) oil embargo in the fall of 1973 produced a national energy crisis, the attention of Government policymakers was focused on the need for a range of remedial measures. In the 1975 budget message, delivered in February 1974, the President announced the initiation of Project Independence to make the United States self-sufficient in energy supplies by 1980. The administration envisioned Federal R&D outlays for energy of $10 billion in the next five years and an even larger investment by the private sector.[2] Federal support included continuation of fission research (including the LMFBR) and supporting energy research, along with greatly expanded programs in solar, geothermal, and fossil energy, and energy conservation, none of which, except for fossil energy, had been sponsored by the Federal Government prior to 1974. The Government was to assume a more direct role in the advancement of energy technologies through a number of demonstration programs. Strong support was to be given to environmental effects research related to energy use and the control of energy pollutants, a program that had been initiated under the sponsorship of the Environmental Protection Agency (EPA) in 1974.

[2]The Federal Government expended approximately $12 billion for energy R&D programs during the 5-year period, 1975-79, whereas total private industrial expenditures for such activities amounted to an approximate $13 billion during the same period.

A new agency, the Energy Research and Development Administration (ERDA) was established in 1974, replacing AEC and assuming most of the fossil energy R&D programs formerly within the Department of the Interior,[4] solar and geothermal energy programs formerly within NSF, and certain energy-related EPA programs. Responsibility for research on and regulation of nuclear safety was vested in another new agency, the Nuclear Regulatory Commission (NRC).

As energy policy continued to be a leading issue, the energy mission agency was elevated to cabinet-level status in 1977 with the establishment of the Department of Energy (DOE), replacing ERDA and embracing power marketing and regulatory activities as well as energy research and development.

All of the energy R&D program areas continued to expand until 1979, and while some showed signs of leveling off, total energy R&D support increased until 1980 (table 3). The 1980 budget message, presented in January 1979, contained the statement that "... with the rapid buildup of Federal energy R&D over the past 5 years and with increases in energy prices and other incentives for private investment... less reliance needs to be placed on the Federal budget to meet national needs."[5]

Demonstration programs in a number of areas (such as coal, oil, gas, solar heating, and hydroelectric) were to be reduced. Funds were not provided in the budget for the Clinch River breeder demonstration project, in line with the administration's nonproliferation policy, although this program subsequently received funds from Congress. The result was a leveling off, rather than a reduction, for nuclear fission programs as a whole. Since a number of other energy programs were still growing, however, the energy R&D total for 1980 represented an all-time high.

The original 1981 budget continued the shift in R&D resources from the nuclear to the nonnuclear side of the ledger. A slight R&D decrease was shown for overall energy programs, mainly the result of the proposed termination, once again, of

[4]Complete assimilation of these programs occurred in 1977.

[5]Office of Management and Budget, "Special Analysis L: Research and Development," *The Budget of the United States Government, Fiscal Year 1980* (Washington, D.C.: Supt. of Documents, U.S. Government Printing Office), p. 296.

Table 3. Federal support for energy R&D programs: fiscal years 1971-83
[Dollars in millions]

Agency and program	Actual											Estimates	
	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
Total	$556	$574	$630	$759	$1,363	$1,649	$2,562	$3,134	$3,461	$3,603	$3,501	$2,889	$2,034
Energy Research and Technology Administration (Commerce)[1]	534	548	596	699	1,205	1,470	2,335	2,867	3,192	3,309	3,170	2,613	1,779
Solar[2]	---	---	---	4	40	94	256	332	463	409	442	248	73
Geothermal	---	---	---	6	25	31	51	105	132	123	131	44	10
Hydropower	---	---	---	---	---	---	2	NA	5	15	7	3	---
Nuclear fission[3]	271	276	295	316	460	520	801	880	875	872	886	927	717
Magnetic fusion	28	31	37	53	98	130	195	207	211	235	259	293	359
Electric energy and energy storage systems	---	---	---	---	---	---	---	88	95	101	85	57	---
Biological and environmental research	65	68	77	87	119	135	163	185	195	215	148	151	121
Supporting research	93	89	89	89	109	113	129	160	192	218	235	244	273
Fossil energy[4]	36	38	49	88	312	369	557	687	668	727	650	407	104
Energy conversation	---	---	---	9	34	66	167	165	226	264	197	84	19
Uranium enrichment[5]	26	31	35	45	2	4	7	44	131	129	131	156	104
Other[6]	16	16	14	2	7	10	6	17	---	---	---	---	---
Nuclear Regulatory Commission[7]	22	26	34	42	64	88	112	137	157	191	227	223	220
Environmental Protection Agency	---	---	---	18	95	90	114	130	113	103	104	52	35

[1]For fiscal years 1971-73 data for the Atomic Energy Commission (AEC) were used; for the period 1974-76 data for the Energy Research and Development Administration (ERDA); for 1977-80 data for the Department of Energy (DOE); and for 1981-83 data reflect the proposed Energy Research and Technology Administration (ERTA) programs.

[2]Includes biomass energy technology programs.

[3]Includes fuel cycle R&D; space and terrestrial applications; and nuclear research and applications programs.

[4]Includes funds for the Department of the Interior programs, 1971-76, transferred to DOE in 1977.

[5]Includes some uranium enrichment programs that are included under nuclear fission in 1978-79.

[6]Includes applied energy technology, 1971-83; advanced technological and assessment projects, 1977; and policy analysis and studies, 1978. Programs in this category were redistributed among various other energy programs with the establishment of ERDA in 1974; includes funds for the Bonneville Power Administration, 1971-76, transferred to DOE from the Department of the Interior in 1977.

[7]In 1974 the safety aspects of AEC were placed under the Nuclear Regulatory Commission (NRC), a new agency.

NOTE: Data for 1971-77 are shown in obligations; data for 1978-83 are shown in budget authority. Detail may not add to totals because of rounding.

SOURCE: National Science Foundation.

the Clinch River project. The revised 1981 budget, however, contained cutbacks in solar, fossil, and environmental R&D programs, as well as in supporting research and in the R&D portion of the Energy Security Trust Fund (for work on synthetic fuels).[6] The combination of these changes produced an equal emphasis on nuclear and nonnuclear R&D efforts within the energy total. By the time Congress had acted on the 1981 proposals, nonnuclear programs still remained dominant, but a change in direction had begun.

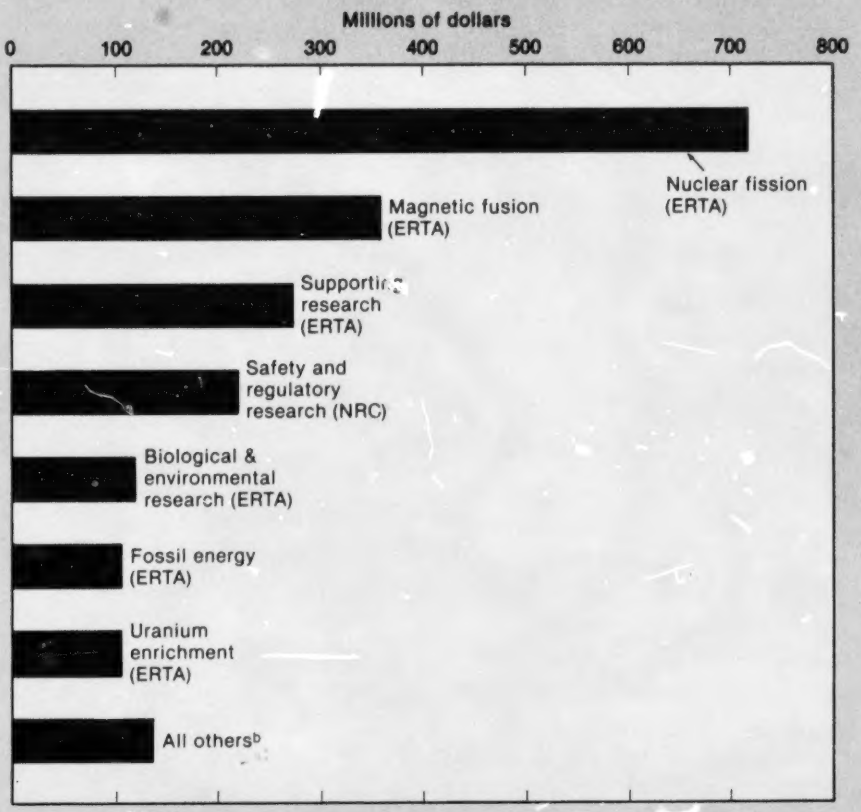
recent shifts in policy

The 1982 budget of the Reagan administration carried this change even further. As part of widespread budget cuts to reduce the overall rate of growth in Federal spending and also as part of a broad economic philosophy, energy R&D programs in all areas except nuclear fission were reduced from levels proposed in the original 1982 budget, and rescissions were also proposed for most of these programs from their 1981 funding levels. The cuts were most severe in fossil energy, solar energy, and energy conservation R&D programs. Nuclear fission programs, however, were substantially increased as the Clinch River project was restored. To help meet nuclear safety problems, the commercial nuclear waste management program was increased over the originally proposed 1982 level, as were R&D activities connected with the damaged Three Mile Island reactor.

The Reagan administration has limited the Federal R&D support role to high-risk, long-run technologies that are far from a stage of commercial application and is using realistic energy pricing and tax and regulatory incentives to stimulate the private sector to introduce near-term energy innovations. Thus, current plans are for continued support to nuclear fission, magnetic fusion, and basic energy research programs while most nonnuclear energy R&D programs are to be phased out or substantially reduced.

In the 1983 budget the overall energy R&D total (excluding R&D plant) was cut by 30 percent to $2,034 million. Within the total, nuclear programs amounted to $1,399 million and nonnuclear programs, to $635 million (chart 2). The reduction for nuclear programs was 13 percent from the 1982 level and for nonnuclear programs, 51 percent. The only demonstration programs still receiving Federal support were found in the nuclear area. To carry out this diminished Federal energy role, the administration proposed in the 1983 budget that a new agency, the Energy Research and Technology Administration (ERTA), be made a subdivision of the Department of Commerce, replacing DOE.

Chart 2. FY 1983 Federal R&D budget authority for major energy programs[a]



[a]Data are based on the 1983 Federal budget.
[b]ERTA solar energy, geothermal energy, energy conservation, and applied energy technology programs, and EPA energy-related environmental programs.
SOURCE: National Science Foundation

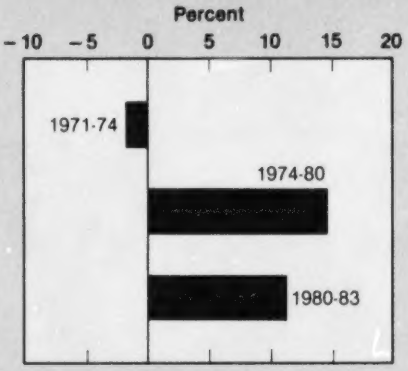
basic research

The basic research effort within the energy function is largely made up of the DOE basic energy sciences program and consists of long-range, mission-oriented research to provide a knowledge base for future energy alternatives.[7] In 1971 the energy basic research total was $93 million, and in the next three years was slightly less. Between 1971 and 1974 an average annual funding decrease of 1.7 percent was recorded (chart 3). A shift occurred, however, in the second half of the seventies. A policy was adopted of ensuring real overall growth in federally supported

[6]In March 1980 the administration revised the 1981 budget downward as part of an anti-inflation strategy.

[7]DOE conducts other basic research programs that are subsumed within the general science function. The effort within that function, which can be considered as energy-*related*, is represented by the high energy physics, nuclear physics, and life sciences research and nuclear medicine applications programs. A proposed total of $463 million in budget authority was shown for these programs in the 1983 budget.

Chart 3. Federal support to energy basic research: Average annual percent change



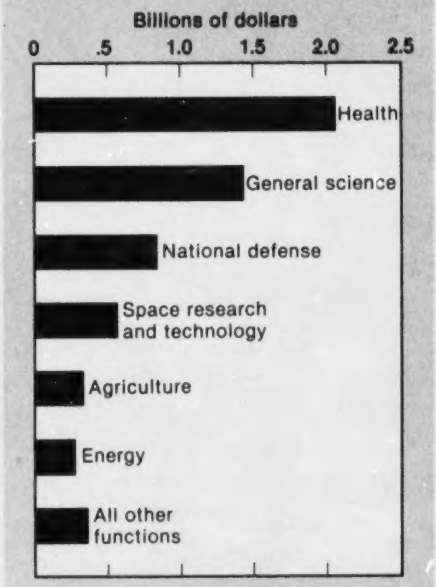
SOURCE: National Science Foundation

basic research, and energy shared in some of that growth. Although a 22-percent increase in energy basic research support occurred in 1975 before the implementation of the new policy, high relative increases in later years were influenced by the decisions of two successive administrations to promote basic research activities across a broad spectrum. Between 1974 and 1980 an average annual gain of 14.6 percent was reflected in energy basic research support.

Growth has continued in the 1980-83 period, although at a slower pace. Gains of about 10 percent in 1981 and again in 1982 were followed by a proposed increase of 15 percent in 1983, to an estimated $276 million. The indicated average annual growth in the 1980-83 period was 11.3 percent (later raised to 12.7 percent). While this growth is more moderate than that in the 1974-80 period, support to energy basic research in the three years from 1980 to 1983 contrasts markedly with the large cutbacks proposed for *total R&D* budget authority for energy programs.

As a share of total Federal basic research support in the 1983 budget energy represented only 5 percent (chart 4). The relative gain over 1982, however, was exceeded only by gains for basic research in the high-priority areas of defense and space.

Chart 4. FY 1983 support to basic research by function



SOURCE: National Science Foundation

section 2.

nuclear energy r&d programs

Four broad program areas comprise the nuclear energy portion of energy research and development. These are nuclear fission, which has always been the largest of any energy R&D program, followed by magnetic fusion, nuclear safety and regulatory research, and uranium enrichment R&D activities. These programs were all sponsored by AEC at the beginning of the seventies, but in 1974 the safety and regulatory aspects became the responsibility of NRC. The other three programs have continued under the sponsorship of the successive energy mission agencies.

Even in periods of greatest funding growth, the nuclear programs, taken together, have shown more moderate advances than the nonnuclear programs. Between 1971 and 1974 support to the nuclear group grew at an average annual rate of 9.6 percent, and between 1974 and 1980 the comparable growth rate was 21.0 percent. Similarly, the average annual rate of decline in the 1980-83 period has been slight—0.6 percent—compared with a sharp reduction (50.0 percent) in support for the nonnuclear programs. A well defined cycle is evident in the early dominance, later deemphasis, and return to dominance of the nuclear R&D programs within the total energy R&D effort (chart 5).

The **nuclear fission** program has always been the largest energy R&D program. The chief purpose here has been the development of economic and safe commercial nuclear reactors for the production of electricity. During the 1971-74 period the nuclear fission program increased at an average annual funding rate of 5.3 percent. This increase related to work on the beginning stages of development of an LMFBR, on advanced converter and thermal reactors, on space propulsion systems, and space electric power development. Between 1974 and 1980 an average annual growth rate of 18.4 percent reflected a heavy focus on breeder reactor projects, such as the LMFBR, as well as on gas cooled, water cooled, and molten salt breeder reactors. Conventional reactor work became less prominent. Significant growth occurred in the commercial nuclear waste management program.

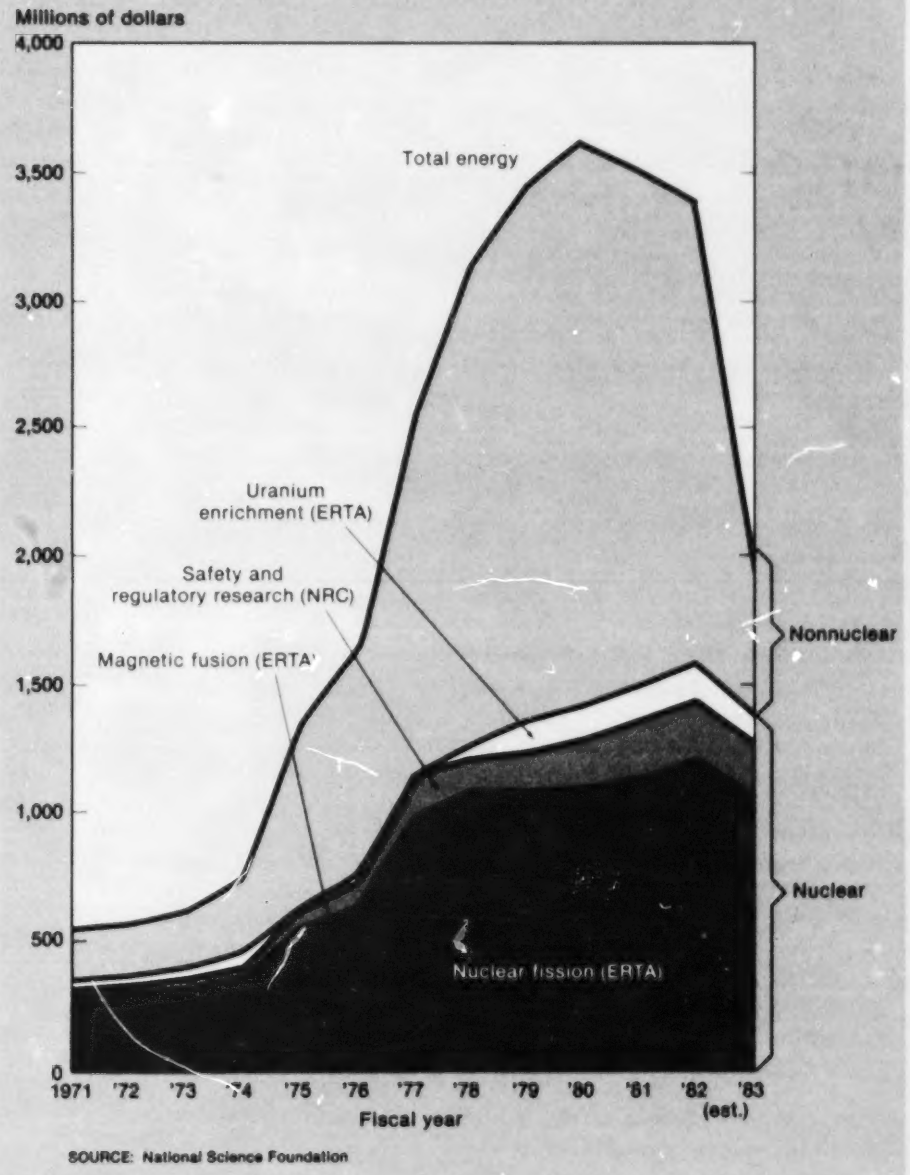
Between 1980 and 1983 an average annual decrease of 6.3 percent in the total fission program reflects a decline in funding for the breeder reactor systems program. The Clinch River breeder demonstration project, which the previous administration had planned to terminate, was retained in the 1983 budget. A decrease was proposed in the LMFBR base program, however, because of advances in fuel design and performance, and R&D funding was eliminated for a large development plant project. Accompanying these decreases was a large proposed decrease in the commercial waste management program, reflecting transfer of funding to the Nuclear Waste Disposal Fund. The converter reactor systems program was also reduced. The overall nuclear fission program was thus reduced to $717 million in the 1983 budget, down 23 percent from the 1982 level.

Magnetic fusion R&D activities, second in funding support after nuclear fission, have shown the largest average annual increases of any nuclear energy R&D program in each selected period. Growth in this program has been continuous throughout the 1971-83 timespan. The goal of the magnetic fusion program has been to develop central electric power generation through a pure fusion working reactor that would meet environmental, economic, health, and safety requirements. Work has centered on confinement systems as embodied in the tokamak fusion concept, with emphasis on toroidal and mirror confinement systems.

In the 1983 budget, confinement systems activities accounted for one-half of all the R&D effort within magnetic fusion. Applied plasma physics activities accounted for one-fifth, as did a group of projects under the heading of development and technology. The applied plasma physics program has been concerned with advancing knowledge for the overall fusion program and includes development of fusion concepts other than tokamaks and mirrors. In the 1983 budget, a total of $359 million was proposed for magnetic fusion, an increase of 23 percent over the 1982 level.

Since 1975 the **safety research** programs

Chart 5. Federal R&D support to energy programs: nuclear in detail



SOURCE: National Science Foundation

of NRC have ranked third in amount of funding for nuclear energy R&D programs. With the establishment of NRC in 1974, funding increased 24 percent over the previous year, and growth after that was continuous until 1981. In the second half of the seventies reactor safety research expanded, with emphasis placed on the loss-of-fluid test facility (LOFT) and loss-of-coolant accidents (LOCA). Between 1981 and 1983 these programs were expected to show declines while increases were expected for the accident evaluation and mitigation, and reactor and facility engineering programs. A basic goal of current NRC research programs is to provide objectively verified safety analysis methods that meet the needs of licensing the Clinch River breeder reactor as well as other regulatory needs. Despite a minimal decrease in the 1983 budget from the 1982 level, an average annual rate of growth of 4.8 percent was seen in the 1980-83 period for these NRC programs.

The R&D portion of **uranium enrichment** activities is a relatively small part of the total uranium enrichment program, which includes production of feed, recovery of enriched uranium, process, and technical support. Uranium enrichment services have been sold by DOE to domestic, foreign, and U.S. Government consumers. Funding for research and development in this area grew substantially after 1978, leveling off at approximately $30 million annually in the years 1979-81, growing to $156 million in 1982, and then dropping 33 percent to $104 million in the 1983 budget proposal. Toward the end of the seventies and into the early eighties development of improved uranium separation processes accelerated. Because of the drop in 1983, an average annual decline of 7.4 percent was shown for the 1980-83 period. The 1983 drop reflects attainment of the major program goal of producing enriched uranium at reduced costs. If the new technology is successful, it may replace the power-intensive gaseous diffusion plants now in use.

section 3.

nonnuclear energy r&d programs

Until 1974 the chief energy R&D programs not considered nuclear in this analysis were the AEC biological and environmental research, AEC supporting research, and the Department of the Interior fossil energy programs.[a] In 1974 Federal support was first provided for solar, geothermal, and energy conservation programs, all of which were assumed by ERDA, and for the EPA energy-related environment R&D programs. Funding for all these programs grew until the late seventies when signs of a leveling off appeared (chart 6). The 1980 budget proposed a turnaround in a number of demonstration programs, although reductions finally occurred that year only in the solar and geothermal areas.

Taken together, nonnuclear energy R&D programs showed an average funding gain of 13.2 percent between 1971 and 1974, more than one-third again the rate of growth shown by the far larger nuclear energy R&D programs. Then, between 1974 and 1980, an explosion of efforts to meet the energy crisis produced an average annual increase of 39.9 percent in funding in the nonnuclear area, this time, almost twice the rate of growth of the nuclear field.

[a]While some of these programs could be considered nuclear-related in the 1971-74 period, their content shifted toward the nonnuclear side as energy concerns broadened. For analytic purposes they are considered nonnuclear in the entire 1971-84 period covered by this study.

But in the 1980-83 period, the decline in funding for these programs has been severe—50.0 percent on an annual average compared with almost no decline on the nuclear side. The proposed reduction from 1982 in the 1983 budget was 51 percent, to a level of $635 million, compared with the 1980 high point of $2,176 million. This sharp reduction included the elimination of electric energy and energy storage systems programs and hydropower activities, as well as decreases in solar energy programs to a total of $73 million in 1983, in geothermal programs to a total of $10 million, in energy conservation programs to a total of $19 million, and in fossil energy, to $104 million, in line with an administration policy of relying on market forces for innovation and growth in those areas.

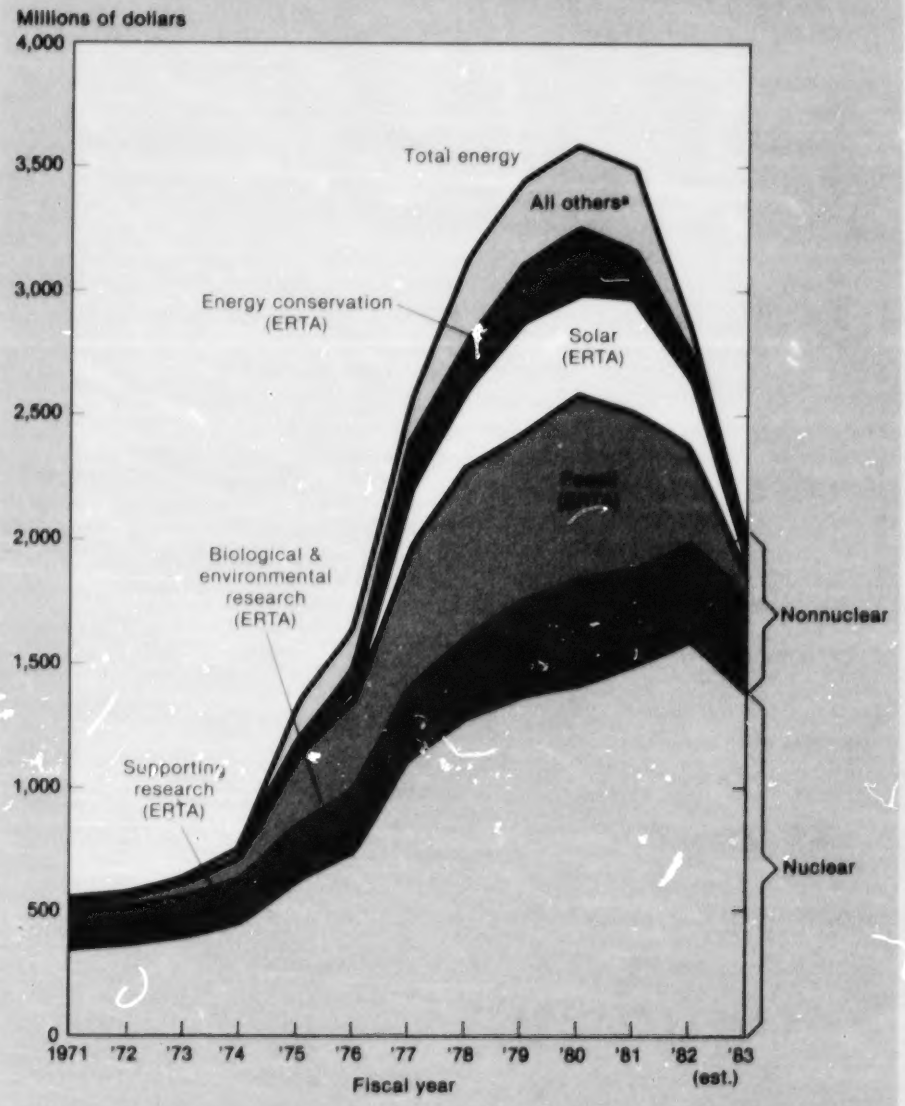
Of the nonnuclear energy R&D programs, only supporting research activities showed a gain in the 1983 budget—12 percent over 1982, to a total of $273 million. The next program in amount of funding was biological and environmental research, which, at $121 million, represented a reduction of 20 percent.

Supporting research programs have grown each year since 1974 for an average annual increase of 16.5 percent during the 1974-83 period. This was the only energy research program, aside from magnetic fusion, to show uninterrupted growth in this period. The purpose of this program is to expand the knowledge base in science and engineering for all the energy technologies. The character of work has been almost entirely basic research conducted in the energy sciences, which include nuclear, materials, chemical, biological, mathematical, and geosciences, and engineering. Although a portion of basic energy sciences research is devoted to nuclear studies, the major portion is nonnuclear; therefore, the total supporting research program is included in the nonnuclear part of this analysis.

Virtually all basic research activities in the energy function are conducted within the supporting research program. Between 1971 and 1974 no growth occurred in basic research, but since 1975 gains have been recorded each year. In the 1974-83 period energy basic research funding grew at an average annual rate of 13.5 percent, to a proposed $276 million, in the 1983 budget.

Biological and environmental research programs showed steady growth from 1971 to 1980. These activities stem from the original biomedical and environmental research program of AEC. Beginning in 1975, greatly increased support was provided for this program. In 1977, the NSF programs dealing with environmental effects of energy were added, and the total program grew 21 percent over 1976, to a total of $163 million. Expansion continued

Chart 6. Federal R&D support to energy programs: nonnuclear in detail



[a]ERTA geothermal energy and applied technology programs and EPA energy-related environmental program.
SOURCE: National Science Foundation

until 1980, but a 31-percent decline occurred in the following year, with little change in 1982, and another decline in 1983. An average annual decrease of 21.1 percent was indicated between 1980 and 1983.

The **fossil energy** program was among the leaders in growth during the 1974-80 period, with an average annual funding increase of 42.2 percent (chart 7). In the years since 1980 the fossil energy program has been redirected from promotion of the development of relatively short-term technologies and from demonstration activities that encourage early commercialization by the private sector to performance of largely generic and technology base research. A decline in funding of 48.7 percent on an average annual basis was shown for the 1980-83 period, the second most rapid decrease of any major energy R&D program.

At its height in 1980, the fossil energy program accounted for 20 percent of the energy R&D total, the result of efforts to meet the goals of Project Independence. Coal resources projects played the predominant role within the fossil area. Work proceeded on improving methods for coal liquefaction, for the direct combustion of coal, for both underground and surface coal gasification, and for developing advanced power conversion systems, among them magnetohydrodynamics, for generating electricity from coal at a high rate of efficiency. These demonstration projects have now been almost entirely phased out. Funding for coal conversion technologies showed a 76-percent decrease from 1982, to $88 million, in the 1983 budget.

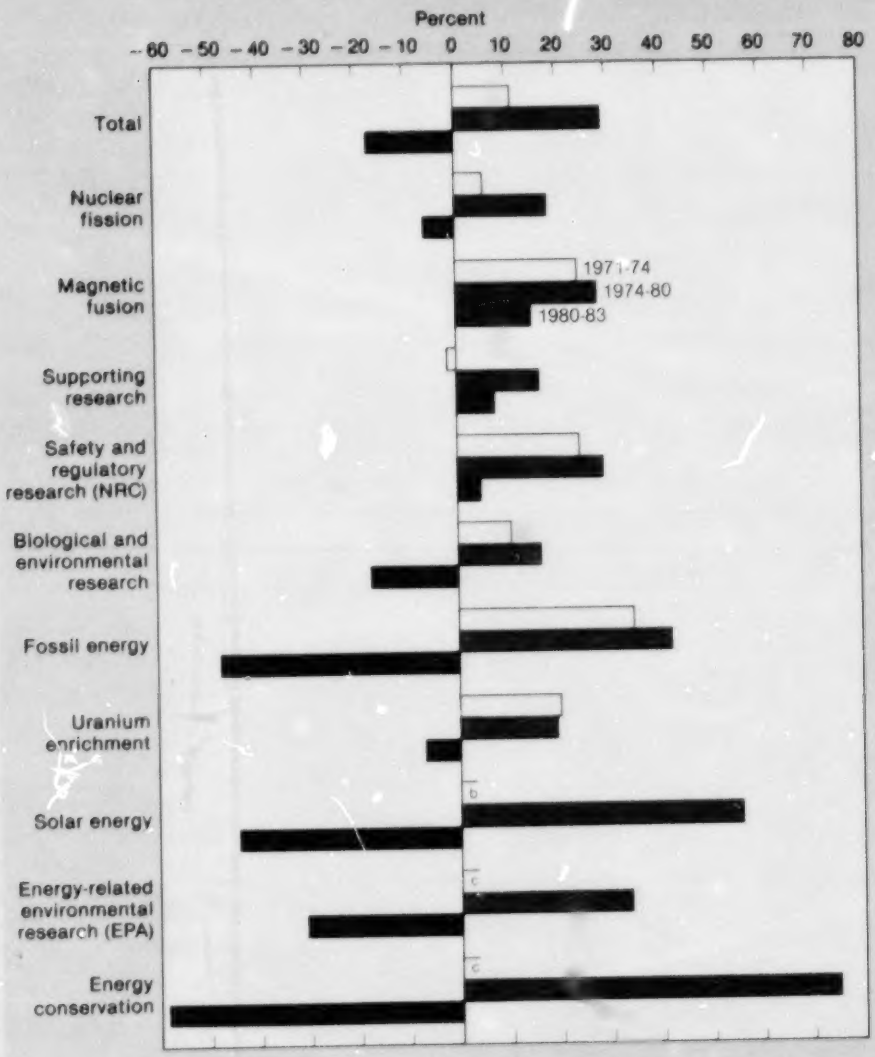
The petroleum portion of the fossil energy program grew to $99 million in 1979, the peak year, reflecting development of enhanced oil recovery technologies and techniques for recovery of oil from shale. In 1983, R&D budget authority for the petroleum program was proposed at $16 million, a 58-percent decrease from the 1982 level.

Gas R&D projects within the fossil energy program increased to $34 million in 1979, largely reflecting work on enhanced gas recovery techniques. Since then, these activities have then been entirely phased out.

The **solar** program, starting at $4 million in 1974, grew to $463 million in 1979, an amount that was 13 percent of the energy R&D total. During those years leading efforts included heating and cooling demonstration projects, as well as work on photovoltaic, solar thermal power, wind energy conversion, and biomass energy systems. Although the solar heating demonstration program was reduced in 1980 and 1981 as no longer necessary to encourage commercialization, the other solar programs were retained until a new administration decided that all aspects of the solar program would receive sufficient incentive through marketplace supply and demand. Between 1980 and 1983 the average annual reduction of 44.4 percent in funding for this program reflected the third largest decline of any energy R&D program area.

The **EPA energy-related R&D** program has focused on pollution abatement, covering the impacts of conventional and advanced energy systems and the health effects of energy-related pollutants. Support for these programs increased at an average annual rate of 34.2 percent during the 1974-80 period. Highest funding

Chart 7. Federal R&D support to energy by major programs:[a] Average annual percent change in selected periods



[a]Shown in descending order of amount of funding in the 1983 budget.

[b]Solar programs received first year funding in 1974; rate of increase starting from small base that year is not comparable, hence increase is shown for the 1975-80 period.

[c]Programs did not exist in 1971.

SOURCE: National Science Foundation

was shown in 1978 at $130 million. The largest share of these funds has been devoted to the air quality control program, which has focused on data accumulation and technology development for limiting air pollution. An amount of $35 million, down 33 percent from the 1982 level, was proposed in 1983 for the entire EPA program. The average annual decline of 30.5 percent during the 1980-83 period was the fourth largest for any major energy R&D program.

Energy conservation projects reflected the steepest gain of all energy R&D programs during the 1974-80 period, moving from $9 million to $264 million. The chief thrust was toward improved efficiency of energy use in transportation, especially automobiles. A substantial share of the effort was also aimed at buildings and community systems, and at industrial systems, to be cost-shared with industry. The present administration, in the belief that strong financial incentives exist within the economy to develop technically and economically promising technologies, has reduced conservation activities to a single program under the heading of energy conservation research; industrial, transportation, and buildings and community systems programs have been completely eliminated. Proposed R&D funding for energy conservation was $19 million in the 1983 budget. The average annual decrease of 58.5 percent for conservation support in the 1980-83 period was the greatest of any energy program.

Geothermal programs have never accounted for more than 4 percent of the energy R&D total, but they have played an important role in the development of geothermal technology. The peak funding year was 1979 when total support was $132 million. At that time efforts were focused on hydrothermal industrialization, geothermal technology development, and geopressure resources. R&D budget authority for these activities totaled only $10 million in the 1983 budget, with the continuance of Government support planned only for geothermal technology development, to be completed in 1985. The goal was development of a technology base for future use by the private sector.

The two remaining nonnuclear energy R&D programs, **electric energy and energy storage systems**, and **hydropower**, never exceeded 3 percent and 1 percent, respectively, of the energy R&D total. Both programs were scheduled for elimination in the 1983 budget.

appendix

energy r&d programs in the 1983 federal budget

appendix

energy r&d programs in the 1983 federal budget

general notes

Within the overall Federal budget there is no R&D budget as such nor are most appropriations for research and development so labeled except in the case of certain program areas in defense, space, energy, and environment. In order to reach an overall Federal R&D figure for analytical purposes, the Office of Management and Budget (OMB) requires the agencies to submit data on their R&D programs in terms of basic research, applied research, and development, and R&D support to universities and colleges. R&D plant data are separately given. The results of the survey conducted in the fall of 1981 were published in "Special Analysis K: Research and Development" as one of the documents of the 1983 Federal budget. This provided a broad view of the R&D portion of the budget along with brief descriptions of the R&D programs of the larger support agencies. It did not, however, provide an array by budget functions or by detailed programs. A report, *Federal R&D Funding by Budget Function, Fiscal Years 1981-83*, was prepared by the National Science Foundation (NSF) in April 1982 to answer the need for that kind of overview.

The sources of data for that report were the reports (Exhibit 44's) made by the agencies to OMB for the special analysis. In addition to these exhibits, NSF also drew upon the budget justification documents of the leading R&D support agencies to obtain greater detail. Some information was also provided informally by some of the smaller R&D support agencies.

For organizational purposes the Federal budget is divided into 17 functional areas, including interest. Funding for these functions plus allowances and undistributed offsetting receipts make up the budget total with no overlap occurring between functions or the agency programs within the functions. Thus, an immediate comparison of the relative emphasis given to various areas of Federal responsibility is obtainable. The energy function is made up of selected programs of the proposed Energy Research and Technology Administration (ERTA) as part of the Department of Commerce and of the Environmental Protection Agency (EPA), and all the programs of the Nuclear Regulatory Commission (NRC).

The following tables and text are taken from the energy chapter of the function report and show funding levels for these programs, as shown in the 1983 budget. An additional table from the function report is provided, showing funding levels for basic research by function in the 1983 budget. All the data shown in the tables are based on budget authority dollars rather than obligations or outlays since budget authority is the basis of congressional funding decisions. The narrative is in the present tense because the report was prepared before any congressional actions had been taken on the 1983 budget.

energy in the 1983 budget[1]

Total R&D budget authority for energy in 1983 is $2,034 million, down $855 million, or 30 percent, from 1982. This budget request reflects an administration policy of phasing down or terminating federally sponsored R&D programs to accelerate the introduction of new energy technologies. Private development of new and improved energy technologies is now encouraged through rising energy prices, tax credits, and regulatory incentives.

[1]National Science Foundation, *Federal R&D Funding by Budget Function, Fiscal Years 1981-83* (prepared by the Division of Science Resouces Studies, April 1982).

R&D budget authority for energy

[Dollars in millions]

Programs	1981	Estimates	
		1982	1983
Total	$3,501	$2,889	$2,034
Energy Research and Technology Administration (Commerce)	3,170	2,613	1,779
Solar	442	248	73
Geothermal	131	44	10
Hydropower	7	3	---
Nuclear fission	886	927	717
Magnetic fusion	259	293	359
Electric energy and energy storage systems	85	57	---
Biological and environmental research	148	151	121
Supporting research	235	244	273
Fossil energy	650	407	104
Energy conversation	197	64	19
Uranium enrichment	131	156	104
Nuclear Regulatory Commission	227	223	220
Environmental Protection Agency	104	52	35

SOURCE: National Science Foundation

solar energy

Total R&D budget authority for solar energy in 1983 is $73 million, down $175 million, or 70 percent, from the $248 million estimated for 1982. This plan reflects the administration's reliance on the principles of marketplace supply and demand.

R&D budget authority for solar energy

[Dollars in millions]

Programs	1981	Estimates	
		1982	1983
Total	$442	$248	$73
Active heating and cooling	40	11	---
Passive and hybrid systems	31	10	---
Photovoltaic energy technology	126	70	27
Solar thermal technology	84	51	18
Biomass energy technology	31	20	7
Conversion technology development	NA	17	5
Feedstock development: aquatic systems R&D	NA	3	2
Wind energy systems technology	58	34	5
Ocean energy systems	34	18	---
Alcohol fuels	18	10	3
Solar international programs	11	4	10
Solar information systems	1	7	---
Solar program support	---	3	1
Solar reserve account	---	6	---
Program direction	7	4	2

SOURCE: National Science Foundation

All solar energy programs, except *solar international programs*, received large reductions or elimination in 1983, to conclude solar demonstration and test facility activities supported in prior years while seeking their transition to private sector operation and support.

Funding of $10 million for *solar international programs* in 1983 represents the final request to complete the United States commitment to the Saudi Arabian Government for solar applications under the Project Agreement for Cooperation in the Field of Solar Energy (SOLERAS).

geothermal energy

R&D budget authority for geothermal energy R&D programs is expected to decrease $35 million, or 78 percent in 1983 to a total of $10 million. The goal of this program is to perform research which will lead to the development of a technology base that could be used for future development by the private sector. Accordingly, this program is structured around three areas: orderly completion of the *hydrothermal industrialization* project, pending access to reliable research data; completion of the government involvement in the *geopressure resource* work as the private sector assumes greater responsibility; and the performance of *geothermal technology development* in hot dry rock and hydrothermal technology. The latter project is planned for further reduction and completion by 1985.

R&D budget authority for geothermal energy

[Dollars in millions]

Programs	1981	Estimates	
		1982	1983
Total	$131	$44	$10
Hydrothermal industrialization	49	9	---
Geopressure resources	31	14	2
Geothermal technology development	49	20	7
Hot dry rock technology	14	10	2
Hydrothermal technology	35	10	4
Program direction	2	2	(1)

[1]Less than $500,000

SOURCE: National Science Foundation

nuclear fission

R&D budget authority for nuclear fission is expected to decline from $927 million in 1982 to $717 million in 1983. This net reduction of $211 million, or 23 percent, includes relatively large cutbacks in converter reactor systems and commercial nuclear waste activities but includes increased emphasis on nuclear fuel cycle activities.

A decrease of $60 million, or 69 percent, in *converter reactor systems* activities includes the termination of the high-temperature reactors and advanced reactor systems programs as well as a deemphasis on light water reactor (LWR) systems. Three Mile Island activities will shift emphasis toward development work associated with the defueling and treatment of abnormal wastes. This shift will reduce the need of additional funding in 1983 by $4 million.

A proposed decrease of $135 million, or 69 percent, in the *commercial waste management* program reflects the transfer of funding for site characterization of exploratory shafts and mine repository-related activities to the Nuclear Waste Disposal Fund in 1983.

A decrease of $22 million, or 4 percent, in 1983 in *breeder reactor* systems includes the elimination of funds for the large developmental plant project of the liquid metal fast breeder reactor (LMFBR) program and a reduction of $58 million, or 20 percent, in the LMFBR base program due to advances in fuel design and fuel performance. A $59 million, or 30 percent, increase is shown in the Clinch River breeder reactor plant project (in conjunction with the licensing activities of the Nuclear Regulatory Commission).

An increase of $8 million, or 18 percent, in the *nuclear fuel cycle* program is directed to waste treatment and storage technology.

The *advanced nuclear systems* program is expected to decrease $4 million, or 11 percent, in 1983. This decrease includes the elimination of the terrestrial applications activities of the space and terrestrial applications program as well as an increase of $3 million, or 29 percent, in flight systems development activities.

R&D budget authority for nuclear fission

[Dollars in millions]

Programs	1981	Estimates	
		1982	1983
Total	$886	$927	$717
Converter reactor systems	79	87	27
High temperature reactors	38	34	---
Light water reactor systems	33	22	4
Three Mile Island activities	6	25	21
Advanced reactor systems	1	4	---
Program direction	1	1	1
Commercial nuclear waste	170	196	61
Remedial actions	7	4	6
Breeder reactor systems	532	563	541
Liquid metal fast breeder reactor (LMFBR)	462	502	487
Large developmental plant	NA	15	---
Clinch River breeder reactor plant project	NA	194	253
Base program	NA	293	234
Water cooled breeder	59	51	42
Shippingport Atomic Power Station	NA	12	12
Light water breeder reactor	NA	31	30
Advanced water breeder reactor	NA	8	---
Program direction	11	10	12
Nuclear fuel cycle	61	45	53
Spent fuel technology	9	6	6
Fuel reprocessing R&D	42	33	33
Waste treatment and storage technology	9	5	13
Program direction	1	1	1
Advanced nuclear systems	38	33	29
Space and terrestrial applications	37	32	28
Flight systems development	NA	10	14
Flight systems support	NA	20	14
Terrestrial applications	NA	2	---
Program direction	1	1	1

SOURCE: National Science Foundation

magnetic fusion

R&D budget authority for magnetic fusion programs shows an increase of $66 million, or 23 percent, to a total of $359 million. More than one-half of the gain is devoted to *confinement systems*, which include the generic toroidal and mirror systems. The proposed increase of $57 million, or 45 percent, in this program

R&D budget authority for magnetic fusion

[Dollars in millions]

Programs	1981	Estimates	
		1982	1983
Total	$259	$293	$359
Applied plasma physics	66	67	73
Advanced fusion concepts	16	17	19
Experimental plasma research	18	16	17
Fusion theory	19	21	23
National MFE computer network	11	13	15
Confinement systems	93	124	181
Toroidal confinement systems	65	90	138
Mirror confinement systems	27	35	43
Development and technology	63	71	74
Magnetics	13	15	17
Plasma engineering	19	16	20
Fusion reactor materials	12	15	16
Fusion systems engineering[1]	14	20	17
Environment and safety	2	3	3
Fusion energy applications	2	2	2
Planning and projects	35	26	26
Tokamak fusion test reactor	22	17	20
Mirror fusion test facility	4	7	6
Fusion materials irradiation test facility	8	2	---
Program direction	3	3	3

[1]Includes funding for the Center for Magnetic Fusion Energy.

SOURCE: National Science Foundation

will cover expansion of experimental studies of basic tokamak physics issues as well as the production of fusion power.

The *applied plasma physics* program is the second largest area within magnetic fusion and shows a proposed increase of $6 million, or 9 percent. This subprogram will continue the increase of applied physics knowledge for advancement of the fusion program and covers development of promising fusion concepts other than tokamaks and mirrors. A large percentage of plasma physicists and engineers employed in all areas of the fusion program receive their training under this program.

The *development and technology* program shows a $4 million, or 5-percent, increase in 1983 that would provide additional funding for the Center for Magnetic Fusion Engineering (CMFE).

The CMFE is subsumed within the *fusion systems* engineering subprogram, which shows an overall net loss of $3 million, or 16 percent.

Planning and projects programs remain unchanged in total funding in 1983 and will continue to provide major plasma sealing and technology development information to the major construction projects.

These programs are being phased out in the light of the administration's reliance on the marketplace to develop and introduce new technologies at rates consistent with their economic potential.

R&D budget authority for electric energy and energy storage systems

[Dollars in millions]

Programs	1981	Estimates	
		1982	1983
Total	$85	$57	---
Electric energy systems	34	24	---
Systems architecture and integration	17	7	---
Power delivery	17	13	---
Generation and storage application	---	4	---
Program direction	1	1	---
Energy storage systems	51	32	---
Electrochemical storage	27	20	---
Physical and chemical storage	23	12	---
Program direction	1	1	---

SOURCE: National Science Foundation

R&D budget authority for biological and environmental research

[Dollars in millions]

Programs	1981	Estimates	
		1982	1983
Total	$148	$151	$121
Human health research	NA	26	26
Health effects research in biological systems	NA	47	38
Environmental research	NA	29	23
Physical and technological research	NA	31	24
Carbon dioxide research	NA	12	8
Health and environmental risk analysis	NA	4	---
Program direction	3	3	3

SOURCE: National Science Foundation

electric energy and energy storage systems

The phaseout of the *electric energy systems* program commenced in 1982 and will be completed in 1983. Prior-year budget authority will permit an orderly completion of the program. Efforts include close coordination with the electric utility industry to achieve the greatest return from government investments to enhance the possibility that the most commercially attractive projects are adopted by the private sector.

No new budget authority is requested for *energy storage systems*. Funds appropriated in 1982 and prior years will be used to bring development project funding to an orderly conclusion.

biological and environmental research

R&D budget authority for environmental programs shows a proposed decrease of $30 million, or 20 percent, to $121 million in 1983. This program represents the Government's only long-term, multidisciplinary research effort to address energy-related health and environmental issues, identify at an early stage any potential adverse effects on human health or the environment, and recommend areas where mitigative action should be taken.

In 1983, all programs except human health research, will be reduced. Research will be focused more heavily on resolving the long-term, generic health and environmental uncertainties associated with the increased production and use of various alternative energy options. Shorter-term, process-specific research will be deemphasized.

supporting research

An increase of $28 million, or 12 percent, to $273 million is anticipated in 1983 in R&D budget authority for *supporting research*. A $35 million, or 15-percent, increase for *basic energy sciences* includes an $8 million, or 35-percent increase, in nuclear science projects and a $6 million, or 24-percent, increase in engineering, mathematical sciences, and geosciences.

The basic energy sciences programs cover long-range, mission-oriented research to provide the fundamental scientific and engineering base on which the Nation's future options depend. New knowledge is developed by sponsoring research in the traditional disciplines.

Within supporting research, *university research support* is planned to decrease from $11 million in 1982 to $5 million in 1983. Phased-out projects may be continued under other agency and non-Federal auspices.

R&D budget authority for supporting research

[Dollars in millions]

Programs	1981	Estimates	
		1982	1983
Total	$235	$244	$273
Basic energy sciences	209	226	261
Nuclear science	20	23	31
Stanford Positron Electron Asymmetric Ring	---	---	[1]6
Nuclear data measurements activity	NA	3	6
Nuclear compilation and evaluation	NA	3	3
Heavy element chemistry	NA	4	4
Isotopic research materials production	NA	10	11
Materials sciences	89	96	109
Chemical sciences	60	64	70
Fundamental interactions	NA	39	44
Processes and techniques	NA	24	26
Engineering, mathematical, and geosciences	24	25	31
Engineering research	NA	4	5
Applied mathematical sciences	NA	4	5
Geosciences research	NA	10	12
Advanced energy projects	6	7	8
Biological energy research	7	9	10
Program direction	3	3	3
Energy research analysis	10	3	3
University research support	12	11	5
Advisory and oversight program direction	3	3	3
Policy and management energy research	1	1	[2]

[1]Program transfer from the National Science Foundation.
[2]Less than $500,000.
SOURCE: National Science Foundation

fossil energy

The overall R&D budget authority request of $104 million for *fossil energy* programs in 1983 is $303 million, or 74 percent, less than the 1982 estimate. Fossil energy R&D is being redirected from accelerating the development of short-run technologies and from demonstration activities that promote early commercialization by the private sector to performing more generic and technology base research. Government support for near-term proprietary technologies is deemphasized. Support for environment-related research continues to be supported. While most R&D work at the pilot plant scale would be terminated, operation of existing Government experimental facilities with unique capabilities (coal combustion and liquefaction systems) would be continued in support of generic and technology base R&D or in support of basic resarch. This funding philosophy applies to the three subprogram areas; continuing funds represent either a winding-down of completed work projects or the maintenance of facilities with unique capabilities whose current short-term capital equipment proves too costly for private investment.

Coal R&D budget authority shows a $271 million, or 76 percent, decrease to $88 million in 1983 with reductions in all programs. Large decreases are proposed in advanced research and technology development, coal liquefaction, combustion systems, and surface coal gasification. The magnetohydrodynamics program will be terminated.

Petroleum R&D budget authority is proposed at $16 million, or $23 million less than 1982, a 58-percent decrease.

Gas R&D programs are terminated by 1983, compared with $9 million in budget authority in 1982.

R&D budget authority for fossil energy

[Dollars in millions]

Programs	1981	Estimates	
		1982	1983
Total	$650	$407	$104
Coal	564	359	88
Coal technology and coal preparation	40	24	9
Advanced research and technology development	51	52	17
Coal liquefaction	184	98	26
Combustion systems	37	31	7
Fuel cells	32	34	10
Heat engines and heat recovery	29	15	---
Underground coal gasification	10	8	1
Magnetohydrodynamics	67	22	---
Mining R&D	33	11	1
Surface coal gasification	70	53	11
Program direction	11	12	8
Petroleum	55	39	16
Advanced process technology	6	4	3
Enhanced oil recovery	16	15	6
Oil shale	32	18	6
Program direction	1	2	1
Gas	31	9	---
Unconventional gas recovery	30	9	---
Program direction	(1)	(1)	---

[1]Less than $500,000.
SOURCE: National Science Foundation

energy conservation

The Federal R&D energy conservation program shows a redefined focus in 1983, with a $64 million, or 77-percent, reduction from 1982, to a total of $19 million. Research will focus on expanding the Nation's scientific knowledge base by supporting generic technology base projects and more fundamental research activities. The administration's energy policy considers that each sector of the economy has strong financial incentives to develop and demonstrate technologies that appear technically and economically promising.

R&D budget authority for energy conservation

[Dollars in millions]

Programs	1981	Estimates	
		1982	1983
Total	$197	$84	$19
Buildings and community systems	42	33	---
Building systems	NA	19	---
Residential conservation service	NA	---	---
Community systems	NA	4	---
Urban waste	NA	5	---
Small business	NA	---	---
Technology and consumer products	NA	---	---
Appliance standards	NA	2	---
Analysis and technology transfer	NA	1	---
Federal emergency management program	NA	(1)	---
Program direction	NA	3	---
Industrial	43	9	---
Waste energy reduction	15	2	---
Industrial process efficiency	14	3	---
Industrial cogeneration	8	---	---
Implementation and deployment	3	2	---
Program direction	3	2	---
Transportation	92	34	---
Vehicle propulsion technology development	47	11	---
Electric and hybrid vehicle RDT&E	34	16	---
Transportation systems utilization	5	1	---
Alternative fuel utilization	4	4	---
Program direction	3	1	---
Energy conservation research	21	8	19
Energy conservation and utilization technology	8	---	18
Appropriate technology	6	3	---
Inventors programs	6	5	---
Program direction	1	(1)	2

(1) Less than $500,000

SOURCE: National Science Foundation

In 1983, all conservation activities appear in a single program for the first time. The terminal technology development programs—*buildings and community systems, industrial conservation,* and *transportation conservation*—are being phased out in 1982. Remaining activities are included in a new program called *energy conservation research.*

In the past, multi-sector programs had been composed of three subprograms: energy conversion and utilization technologies (ECUT), appropriate technology, and energy-related inventions work. Now ERTA is seeking $19 million only for the ECUT subprogram and program direction necessary for ECUT and for closing out the conservation program. Program direction funding also covers closeout of the *electric energy systems and energy storage* programs.

uranium enrichment

The 1983 R&D budget authority request for *uranium enrichment* activities is $104 million, or $52 million (33 percent), less than 1982. The uranium enrichment activities program is designed to meet domestic, foreign, and U.S. Government requirements for uranium enrichment services at an economically attractive price. As a result of economic analyses, it was determined that a 3-percent, or $3 million reduction, was consistent with this policy.

The *advanced isotope separation* program, by contrast, is scheduled for a 62-percent, or $49 million, reduction in 1983. The goal of this program is to develop a technology that will provide for the production of enriched uranium at a significantly reduced cost. This technology, if successful, could be used to replace the power-intensive gaseous diffusion plants. The reduction reflects completion of a major data package associated with the base science and technology development effort.

Uranium resource assessment R&D activity was cancelled in the 1982 budget revision.

R&D budget authority for uranium enrichment

[Dollars in millions]

Programs	1981	Estimates	
		1982	1983
Total	$131	$156	$104
Uranium enrichment activities	64	76	73
Uranium resource assessment	4	---	---
Advanced isotope separation technology	64	80	30

SOURCE: National Science Foundation

nuclear regulatory commission

R&D budget authority for the NRC Office of Nuclear Regulatory Research is expected to decrease $3 million, or 1 percent in 1983, to a total of $220 million. A basic objective of the NRC programs is to provide objectively verified safety and analytical methods which meet the needs of licensing the Clinch River breeder reactor project, other regulatory activities, and public confidence.

Most research safety programs are proposed for increases except for the *LOFT (loss-of-fluid test)* experimental program, which shows a $27 million, or 64-percent decrease, and the *LOCA (loss-of-coolant accidents)* and transient research program, which shows a decline of $1 million, or 3 percent, in 1983.

A $6 million, or 73-percent, increase for the *advanced reactors* safety program would support research on gas-cooled reactors as well as the fast breeder reactor licensing at Clinch River. *Accident evaluation and mitigation* research is increased by $14 million, or 43 percent, to provide NRC with the technical bases required to mitigate the consequences of severe accidents.

R&D budget authority for the Nuclear Regulatory Commission

[Dollars in millions]

Programs	1981	Estimates	
		1982	1983
Total	$227	$223	$220
LOCA (loss-of-coolant accidents) and transient research	46	31	30
LOFT (loss-of-fluid test)	42	42	15
Accident evaluation and mitigation	26	33	47
Advanced reactors	10	8	13
Reactor and facility engineering	28	34	38
Facility operations and safeguards	13	13	14
Waste management	10	12	14
Siting and environment	13	9	9
Systems and reliability analysis	14	15	16
Program technical support	26	26	25

SOURCE: National Science Foundation

environmental protection agency

The energy R&D program under EPA is expected to decrease by $18 million, or 34 percent, to $35 million in 1983. This overall cut was applied to all remaining 1982 programs.

The *multimedia energy* program received the smallest cut—3 percent—and will continue to address those energy-source problems that have the potential to adversely affect the environment, such as acid rain.

A cut of $9 million, or 87 percent, in the *oxidants energy* program reflects curtailment of the fundamental combustion modification program as well as assessment of health and ecological effects of ozone and other photochemical oxidants.

The *gases and particles energy* program is proposed for a decrease of $3 million, or 28 percent. Emphasis will continue on activities that directly support EPA regulatory development and implementation. The cut represents the completion of evaluation of conventional fabric filter technologies.

R&D budget authority for the energy R&D program of the Environmental Protection Agency

[Dollars in millions]

Programs	1981	Estimates	
		1982	1983
Total	$104	$52	$35
Multi-media energy program	41	25	24
Oxidants energy	13	11	1
Gases and particles energy	20	12	9
Hazardous air pollutants energy	5	---	---
Water quality energy	12	3	---
Drinking water energy	2	---	---
Industrial waste water energy	3	1	---
Solid waste energy	1	---	---
Chemical testing and assessment technology	6	---	---
Municipal spills	1	1	---

SOURCE: National Science Foundation

R&D budget authority for basic research by function

[Dollars in millions]

Programs	1981	Estimates	
		1982	1983
Total	$5,107	$5,346	$5,855
Health	1,951	1,999	2,066
General science	1,256	1,318	1,439
National defense	610	683	828
Space research and technology	445	482	573
Agriculture	281	292	323
Energy	220	239	276
Natural resources and environment	131	123	112
Transportation	89	99	111
Education, training, employment, and social services	66	60	68
Commerce and housing credit	17	19	22
Veterans benefits and services	15	13	14
International affairs	12	9	10
Community and regional development	5	6	6
Administration of justice	5	4	4
General government	3	3	4
Income security	3	(1)	(1)

[1]Less than $500,000.

SOURCE: National Science Foundation

other science resources publications

Science Resources Studies Highlights

R&D Funds

	NSF No.	Price
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Companies Plan R&D Expenditure Increases for 1983: Growth Rate Down	82-324	-----
National R&D Expenditures Expected to Reach $85 Billion in 1983	82-311	-----
Academic R&D Expenditures Increased 4% in Real Terms Between FY 1979 and FY 1980	82-309	-----
1980 Federal Obligations to Universities and Colleges Rose Slightly in Constant Dollars	82-301	-----
Industrial R&D Expenditures in 1980 Show Real Growth for Fifth Consecutive Year	81-331	-----

S/E Personnel

Projected Employment Scenarios Show Possible Shortages in Some Engineering and Computer Specialties	83-307	-----
Manufacturing Employment Becoming Increasingly More Technological	83-303	-----
Growth in Science and Engineering Employment Accelerated in 1980 to 1981—But Demand May Have Slackened in 1982	83-300	-----
Labor Market Slackens for New Science and Engineering Graduates	82-330	-----
Growth in Employment of Science and Engineering Doctorates Continues, Led by Computer Scientists	82-328	-----
Science/Engineering Doctorate Production Increases in 1981; More New Doctorates Seek Nonacademic Positions	82-323	-----
Employment of Recent Science and Engineering (S/E) Graduates in S/E Fields Increased	82-320	-----
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Growth in Scientific and Engineering Employment Slows Between 1978-80	82-303	-----

Detailed Statistical Tables

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Scientists and Engineers From Abroad, 1976-78	80-324	-----

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National Patterns of Science and Technology Resources, 1982	82-319	$5.00
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